e-ISSN:2582-7219

INTERNATIONAL JOURNAL OF MULTIDISCIPLINARY RESEARCH IN SCIENCE, ENGINEERING AND TECHNOLOGY

Volume 5, Issue 6, June 2022

INTERNATIONAL STANDARD SERIAL NUMBER INDIA

Impact Factor: 7.54

| ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 7.54|

| Volume 5, Issue 6, June 2022 |

| DOI:10.15680/IJMRSET.2022.0506065 |

Net Present Value and Life Cyclecost Analysis of Road by Using ANN Method

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ABSTRACT: Highway development requires massive investment not just in constructing new facilities, but in repairing and maintaining existing facilities as well. In developing nations, such as India, there is a lack of funding needed for new building and maintenance and repair infrastructure projects. The emphasis now is on building long-term pavement. Vast majority our roadways are bitumen-sourced pavement which exhibit early signs of strain such as routing, cracks, ageing, etc. due to growing loads, traffic intensity, high pressure of tyres, etc. Concrete pavement may be used as a compared with conventional bituminous pavement. The application of white tops on the existing bituminous pavement is one of the potential alternative regeneration options to bituminous overlays. In this research the analysis of the cost of concrete and bitumen pavements via the use of ANN is evaluated and suggests an effective alternative.

KEYWORDS: Life cycle cost analysis (LCCA), Life cycle cost (LCC) Road engineering, Life cycle thinking; Net present value; Equivalent uniform annual cost

I. INTRODUCTION

The LCCA material in this chapter is provided rigid pavement and LCCA are an economical technique for comparing options that meet a requirement for the lowest cost option. In this research the analysis of life cycle costs of masonry and bitumen pavement is evaluated and an advantageousoptionis offered.

With the increasing focus on sustainability, the road industry is confronted with the challenge of considering sustainable practices. However, enabling sustainable transition, in combination with ensuring durability, requires high levels of investments. Because agencies are often constrained by inadequate funds for investments, the assessment of future costs over longer periods has gained attention. Considering budgetary constraints for projects, agencies need to use rigorous decision-making methodologies that provide insights about long-term economic viability of investments. One of those methodologies is life cycle cost analysis (LCCA), which evaluates the economic burden of an asset's life cycle while still focusing on its durability.

LCCA requires thorough identification of all materials and processes used at every phase. However, the practical application of LCCA depends on several factors. Examples include the availability of credible supporting data, insights into structural characteristics and material properties, modeling deterioration to predict the pavement condition, and the availability of guidelines to estimate user costs. Additionally, it is indicated that different LCCA models are used interchangeably while they cannot be linked due to the lack of consistency in system boundaries and input parameters. Some authors suggest a hybridized eco-efficiency analysis, which combines life cycle assessment (LCA) and LCCA. Others propose an LCCA based on optimizing performance and available funds. Another type of analysis that is proposed, is a new probabilistic simulation optimization LCCA that takes into account the uncertainty of the input parameters

1.1 Life Cycle Cost Analysis of Road

Roads are among the most important public assets in all countries. Road improvements bring immediate and sometimes dramatic benefits to road users through improved access to hospitals, schools, and markets; improved comfort, speed, and safety; and lower vehicle operating costs for these benefits to be sustained, road improvements must be followed by a well-planned program of maintenance.

LCCA is a process of evaluating the economic performance of a structure over its entire life. LCCA is especially useful when project alternatives that fulfil the same performance requirements, but differ with respect to initial costs and operating costs, have to be compared in order to select the one that maximizes net savings.

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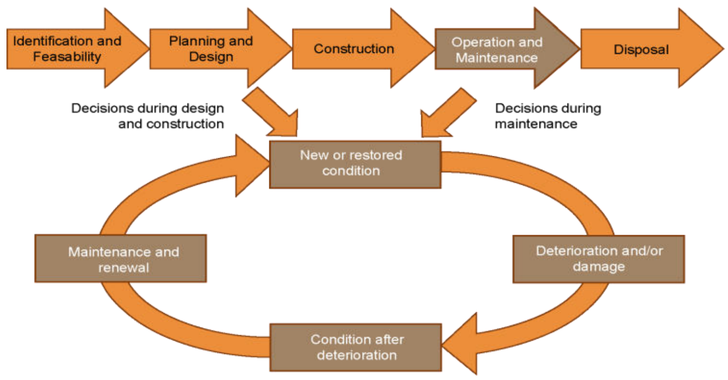
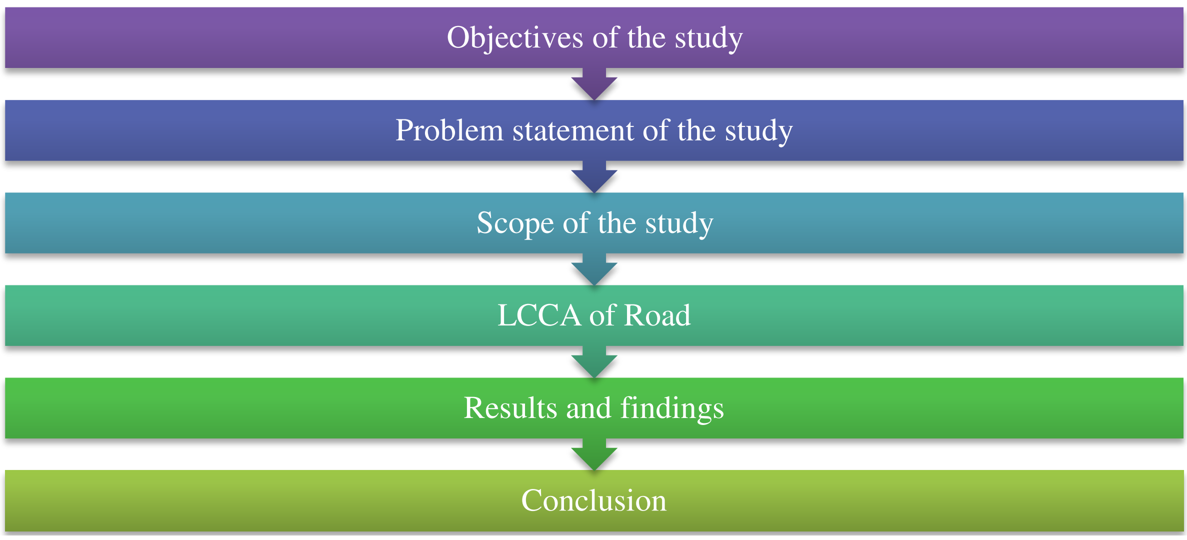
LCCA for road is required because roads, and means of transport, make a crucial contribution to economic development. Poorly maintained roads constrain mobility, significantly raise vehicle operating costs, increase accident rates and their associated human and property costs, and are needed to be deal.
To reduce the overall cost of the road right from construction cost to its repair cost the high quality material constructions with regular preventive maintenance is required Preventive Maintenance: Work undertaken that preserves the existing pavement, retards future deterioration, and improves the functional life without substantially increasing the structural capacity.
Neglected roads steadily become more difficult to use, resulting in increased vehicle operating costs (more frequent repairs, more fuel use) and a reluctance by transport operators to use the roads. This imposes a heavy burden on the economy: as passenger and freight services are curtailed, there is a consequent loss of economic and social development opportunities.

1.1.1The Life Cycle of a Road

The general life cycle of a road is presented in Fig. This diagram differentiates two approaches for material flows. The first approach is linear, represented by phase 1 raw materials extraction until phase 5B landfill or 5C energy recovery after incineration, which considers material flows where new virgin materials are required after the end of life (EOL) of the previous system. The second approach is circular, represented by phase 1 raw materials extraction until phase 5A recycling, which has the goal to utilize products at the highest value of all time and takes into account material flows where primary materials are saved due to recycling and reuse of waste products after the EOL of the previous system.



Flowchart of methodology –



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II. METHODOLOGY

1 Life Cycle Cost Analysis Procedure

Figure –LCCA

The following stages are included in the LCCA methodology:

- Initial building cost estimate.
- Maintenance estimates.
- Estimate user costs of road transport Cost of life cycle determination

In this research the costs for the building and maintenance of the pavement are estimated using the net actual life-cycle cost analysis approach. The results are computed. The calculation for cost of capital is provided by IRC SP- 30 (2009).

4.2 General Methodology

Life - Cycle Research is a structured process used for the evaluation of public projects with different long-term implications. The procedure is conducted by summarizing the monetary equivalence of all advantages and expenses throughout the study period at their respective times. They are then transformed into a common temporal dimension in order to appropriately evaluate various options.

4.3 Economic Indicators

There are many forms of macroeconomic factors for the outcomes of the study in the economic assessment of projects. The most often used are cash flow (NPV), cost-effectiveness ratios (B/C), equivalent yearly cost (EUAC), and an internal return rate (IRR). The choosing of the indicator is mainly dependent upon the analytical level and context. It may also rely in certain aspects just on degree of uncertainty.

For instance, the IRR form is the ideal indicator for project evaluations in poor nations when the interest rate is quite unpredictable. On either side, when the analytical duration of the project is uncertain or it is anticipated that the project would continue forever, the EUAC is the preferable format since the EUAC equations are developed on the premise that now the work will last forever.

The selection of the performance concept must in theory take into account the following questions:

- Are the analytical advantages included?
- How much decision and/or analysis is involved?
- What techniques do the specific agency's criteria meet?
- In contrast to future spending, how significant is the original capital investment?
- What analytical technique is the decision maker's best understandable?

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Table - Equations of Economic Indicators

Eq. No	Indicator	Abbreviation	Equation
1	Net Present Value	NPV	$NPV = \sum_{t=0}^{T} \frac{B_t - C_t}{(1+d)^t}$
2	Benefit-Cost Ratio	B/C	$\frac{PVB}{PVC} = \sum_{t=0}^{T} \frac{B_t / (1+d)^t}{C_t / (1+d)^t}$
3	Equivalent Uniform Annual Costs	EUAC	$EUAC = NPV \left[\frac{1(1+d)^t}{(1+d)^t - 1} \right]$
4	Internal Rate of Return	IRR	$\sum_{t=0}^{T} \frac{B_t - C_t}{(1+IRR)^t} = 0$

NPV = Net present value of future costs and benefits, IRR = Internal Rate of Return, B/C = Benefit/Cost
PVB = Present value of future benefits, PVC = Present value of future costs
d = Discount Rate , t = time of incurrence (year), T = Lifetime of the project or Analysis period (years)
B_t= Benefits to be gained at time t, C_t= Costs to be incurred at the time t

As the LCCA secondary analysis seeks to evaluate projects that have similar category advantages but cost uneven, the Present Values Value (NPV) is regarded as the suitable (and common) measure to compare project economic difference. With its additives, the Payback Period indication enables the analyst to consider only different expenses (or benefits) while maintaining consistency in the assessment process. This feature greatly lowers the calculations required in the analysis. All known (or supposed) equal costs or benefits do not need to be assessed.

4.4 LCCA Procedure

In the following stages, the LCCA structured method may be outlined:

1. Define the options for the project.

2. Decide the approach: likely vs. decisive.

3. General economic factors selection: Discount rate, period of analysis.

4. Establish an alternate spending stream:

a) Design and timing of rehabilitative policies.

b) Agency cost estimate.

c) Estimate user cost differential.

d) Estimate of societal differential costs.

5. Each option calculates Net Present Value.

6. The results/sensitivity analysis compares and interprets.

7. If necessary, reassess design strategies.

Procedure Of ANN For Construction

We have used MATLAB to evaluate construction delay in this project, Artificial Neural Network. MATLAB is a program that uses the neural network toolbox to evaluate the time delay. Multiple network algorithms are included of NN Tool Box. We offer time input and output optimisation by utilising the NN technique. The method for analysing time delays is followed step by step.
Step 1: Install the program.
Step 2: We launch MATLAB by clicking the Start button. Neural Network Toolbox includes MATLAB software (ANN)

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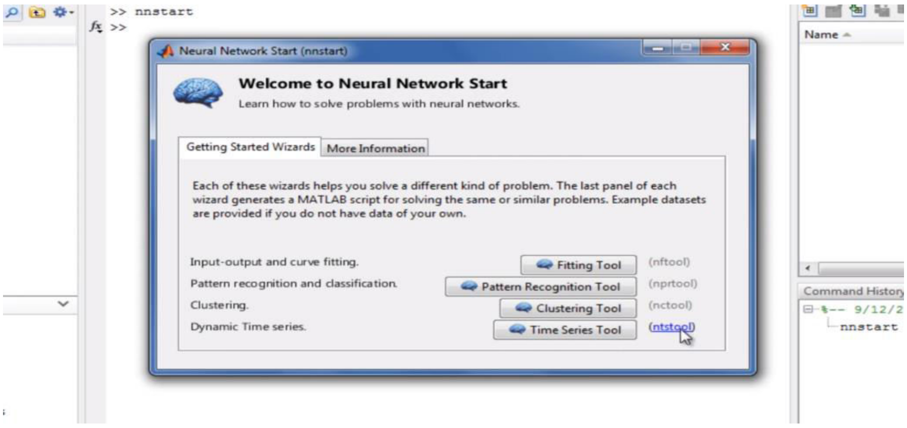
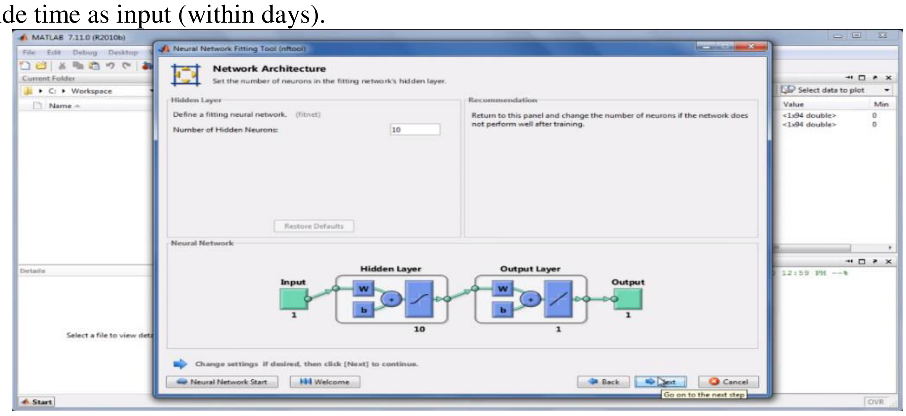
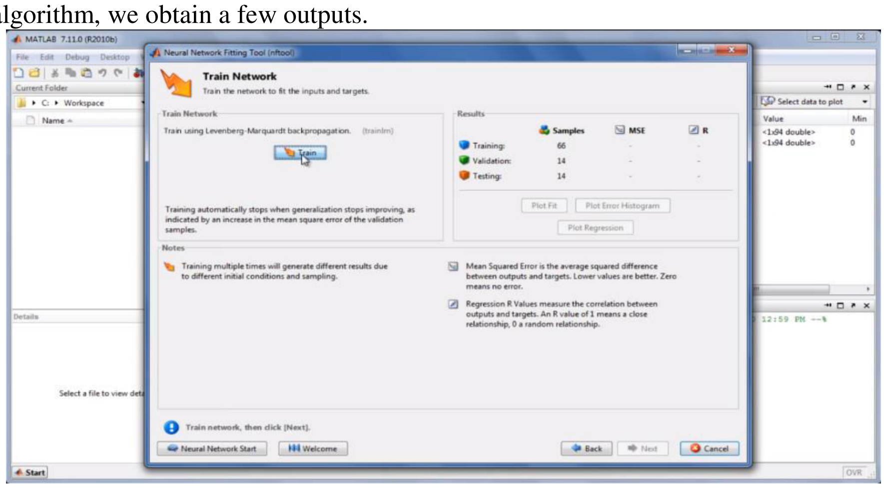
Step 3: Select Choose the toolbox ANN. ANN toolbox is a multiple NN algorithm applied



Step 4: We provide time as input (within days).



Step 5: By ANN algorithm, we obtain a few outputs.



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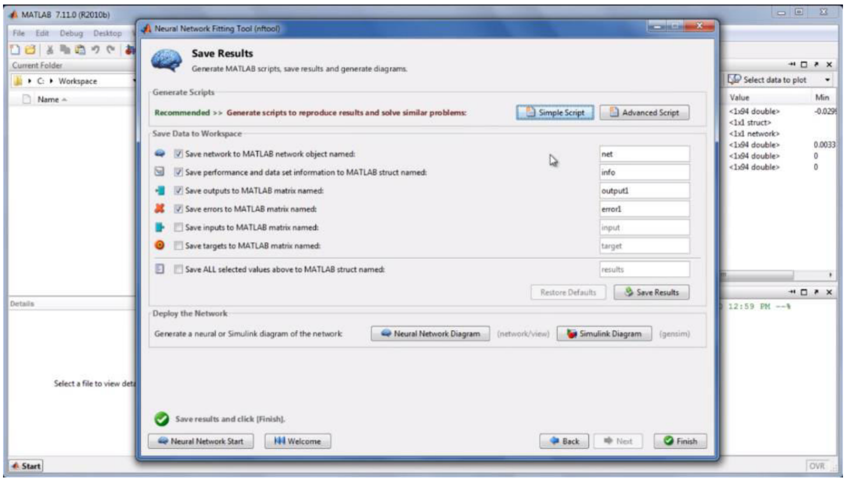
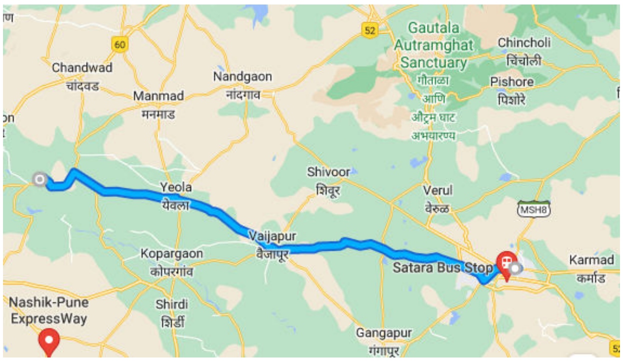
Step 6: Achieve growth all of the outputs. It's really the finest performance.



Step 7: Compared to the intended output, optimised output. The output intended is zero.

III. ANALYTICAL STUDY

5.1 Study Aurangabad Highway to Kolwadi Road



For the present case study for ANN input annual maintenance cost was required to predict future maintenance cost. Total 20 years data is gathered from billing engineer Mr.AmolGarole from StupConsultant

5.2 For Rigid Pavement

Up gradation of Package-I from Km. 0+000 to Km. 47+800 to 2 lane with paved shoulder configuration in the state of Maharashtra.

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Table - General Abstract of Cost for Rigid Pavement

For Flexible Pavement

GENERAL ABSTRACT OF COST			
Length of Project -(47.80 Km)			
Bill No	**Item of works**	**Amount (Rs. Crs.)**	**% of Total Cost**
1	SITE CLEARANCE AND DISMANTLING	2.13	0.95%
2	EARTH WORK	41.80	18.70%
3	GRANULAR SUB-BASE	24.51	10.96%
5	CONCRETE PAVEMENT	87.47	39.13%
6	SLAB, BOX AND PIPE CULVERTS AND UNDERPASS	18.10	8.10%
7	MAJOR AND MINOR BRIDGES	8.03	3.59%
8	DRAINAGE AND PROTECTION WORKS	15.85	7.09%
9	TRAFFIC SIGNS, MARKING AND OTHER APPURTENANCES	1.81	0.81%
10	BUS BAY and TRUCK LAY BAY	1.88	0.84%
11	MISCELLANEOUS (Median work and Utilities across the highway)	5.58	2.50%
12	TOLL PLAZA	3.98	1.78%
13	MAJOR AND MINOR JUNCTIONS	8.17	3.65%
	TOTAL	**223.54**	
	Total project Cost Per Km (Rs. Crs.)	**5.67**	

Up gradation of, Package-I from Km. 0+000 to Km. 47+800 to 2 lane with paved shoulder configuration in the state of Maharashtra

Table General Abstract of Cost for Flexible Pavement

GENERAL ABSTRACT OF COST			
Length of Project -(47.80 Km)			
Bill No	**Item of works**	**Amount (Rs. Crs.)**	**% of Total Cost**
1	SITE CLEARANCE AND DISMANTLING	2.13	1.05%
2	EARTH WORK	41.80	20.59%
3	GRANULAR SUB-BASE	24.51	12.07%
5	PAVEMENT	98.00	48.26%
6	SLAB, BOX AND PIPE CULVERTS AND UNDERPASS	18.10	8.91%
7	MAJOR AND MINOR BRIDGES	8.03	3.96%
8	DRAINAGE AND PROTECTION WORKS	15.85	7.80%

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9	TRAFFIC SIGNS, MARKING AND OTHER APPURTENANCES	1.81	0.89%
10	BUS BAY and TRUCK LAY BAY	1.88	0.92%
11	MISCELLANEOUS (Median work and Utilities across the highway)	5.58	2.75%
12	TOLL PLAZA	3.98	1.96%
13	MAJOR AND MINOR JUNCTIONS	8.17	4.02%
	TOTAL	**203.06**	
K	**Total project Cost Per Km (Rs. Crs.)**	**5.19**	

Periodic Maintenance

Table - Periodic Maintenance (During)

Periodic Maintenance (During O&M Period)		
Appointed date as :	**1-Jan-2017**	
COD: (commercial operation date)	**24-Jun-2018**	(Construction period = 1 year and 6 months=18months = 540 days)
End of Concession:	**23-Jun-2048**	(Operation period 30 years)
Frequency for Periodical Renewal:		
5Years (Ist Periodical Renewal) :	24-Jun-2022	(Periodical Renewal assumed in the present analysis)
10Years(2nd Periodical Renewal) :	24-Jun-2027	(Periodical Renewal assumed in the present analysis)
15Years(3rd Periodical Renewal) :	24-Jun-2032	(Periodical Renewal assumed in the present analysis)
20Years(4th Periodical Renewal) :	24-Jun-2037	(Periodical Renewal assumed in the present analysis)
25 Years (5th Periodical Renewal):	24-Jun-2042	(Periodical Renewal assumed in the present analysis)

Cost for Periodical Renewal (at Present Rates for 1st, 2nd periodical slab)

Table - Cost for Periodical Renewal (at Present Rates for 1st, 2nd periodical slab)

Description	**Unit**	**Qty**	**Rate**	**Amount (Rs.)**
Tack Coat 2 on bituminous surface- 2.0 kg /10sqm	M^2	567,241	9.75	5,530,604
Tack Coat 1 over primed base - 2.5 kg /10sqm below DBM	M^2	567,241	9.75	5,530,604
Quantity of BC (Main carriageway 2L+PS and 4L+PS)	M^3	22,690	5267.45	119,516,628
Quantity of BC (Service Roads)	M^3	-	5267.45	-
Quantity of DBM (Main Carriageway for 2nd Periodic renewal)	M^3	-	5029.90	-
Earthwork in Shoulders	M^3	49,205	302.15	14,867,254
Thermoplastic Paint (Lane/edge marking &Arrow painting)	M^2	17,727	657.15	11,649,254
Total Cost for 1 and 2 periodic renewal with BC:				**151,563,741**

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Cost for Periodical Renewal (at Present Rates for 1st, 2nd periodical slab)

Table -Cost for Periodical Renewal (at Present Rates for 1st, 2nd periodical slab)

Description	**Unit**	**Qty**	**Rate**	**Amount (Rs.)**
Tack Coat 2 on bituminous surface- 2.0 kg /10sqm	M²	567,241	9.75	5,530,604
Tack Coat 1 over primed base - 2.5 kg /10sqm below DBM	M²	567,241	9.75	5,530,604
Quantity of BC (Main carriageway 2L+PS and 4L+PS)	M³	28,362	5267.45	149,395,786
Quantity of BC (Service Roads)	M³	-	5267.45	-
Quantity of DBM (Main Carriageway for 2nd Periodic renewal)	M³	59,560	5029.90	299,582,589
Earthwork in Shoulders	M³	49,205	302.15	14,867,254
Thermoplastic Paint (Lane/edge marking &Arrow painting)	M²	17,727	657.15	11,649,254
Total Cost for 4,5 and 6 periodic renewal with BC:				**181,442,898**
Total Cost for 3rd periodic renewal with BC and DBM :				**486,556,091**

IV. CONCLUSION

- LCCA finds that concrete pavement may be regarded as more advantageous than bituminous pavement and concrete overlays as a good alternative for the recovery of existing bituminous pavement.
- Mat lab predicted value for flexible was 0.993 and which is for rigid was almost 1, where R indicates range for periodic maintenance cost.
- It has been discovered that rigid pavement are operating longer than a flexible pavement, based on the findings of this research study. The life cycle cost of a rigid pavement cover is 1 kilometer less than the flexible pavement cover in a period of forty (40) years of analytics for a total of 64 million ETB (Existing-To-Bank). Routine and regular maintenance expenses of the same one-kilometer length for flexible pavement for three decades are 1.1 times more than inceptional building costs, and need an increase of 7,3million for construction and maintenance than rigid pavement. Initial construction costs are 10.08 percent greater for rigid pavement.
- Flexible pavement can be built and maintained fast and thus minimise congestion. These pavements are usually black in colour, offering a substantial decrease in the clearing of the road surface and contribute to the development of line marks. These pavement are robust, safe and durable compared to rigid pavement.
- In this research, the life cycle cost studies for the road are completed for 1 km using Rigid and Flexible pavements, and they are performed in MATLAB software.
- From the research study of LCCA of Road with rigid and flexible pavement it is conclude that road with flexible pavement have Initial Construction cost is high for Rigid Pavement than road with flexible Pavement by 40-45%.
- After the analyzing life cycle cost road for 30 years, LCC for road with flexible pavement are 128.73 Cr and LCC for road with rigid pavement are 119.94 Cr, and it is conclude that Life cycle cost for road with rigid pavement is cheaper by 6.83% than road with flexible Pavement.
- Similarly from the MATLAB analysis output results for road with rigid are 99.5% and outputs for flexible pavement are 99.94% ,so its conclude that road rigid pavement are more economic than flexible.

- In order to realize an optimal trade-off between investment and maintenance of road projects, LCCA should be applied. LCCA has several applications, including help in selecting the best alternative to meet a project objective.
- The feasibility study on selecting a road goes beyond costs and LCCA e.g. the geological conditions; duration of construction, environmental impact, technology availability, constructability and ecological and even political consideration dominates the decision.
- To properly plan for future repairs or scheduled maintenance in a road, it is beneficial to perform a LCCA of the different options involved for each anticipated major repair to ensure the greatest cost efficiency over the life of the road

V. RECOMMENDATION

With the increasing pace of changes in the technology and the current economic down turn; organizations around the world are focused more on cost-effective and value-added technology/research in the field of advancement of road technology. Life cycles are estimated using relevant deterioration models based on data collected over many inspection cycles. The cost-effective strategies consider the costs of various competing alternatives over a specific duration or time period such as the remaining useful life of a particular road system. A broad level of research with adequate funding could be initiated down the road to develop new techniques in design, construction and maintenance of roads by applying LCCA and other techniques (including risk analysis and operation research principles)

REFERENCES

1. Peško, I., Mučenski, V., Šešlija, M., Radović, N., Vujkov, A., Bibić, D., &Krklješ, M. (2017). Estimation of costs and durations of construction of urban roads using ANN and SVM. *Complexity*, *2017*. https://doi.org/10.1155/2017/2450370
2. Audu, H., Oghorodje, E., &Oviri, D. (2016). Sensitivity Analysis on Flexible Road Pavement Life Cycle Cost Model. *Nigerian Journal of Technology*, *35*(2), 278. https://doi.org/10.4314/njt.v35i2.7
3. Rezgui, Y., El-Sawah, H., & Moselhi, O. (2014). Comparative study in the use of neural networks for order of magnitude cost estimating in construction. *Journal of Information Technology in Construction*, *19*(January), 462–473.
4. Ketema, Y., Quezon, E. T., & Kebede, G. (2016). Cost and Benefit Analysis of Rigid and Pavement: Case Study in Chancho-Derba-Becho Road Project. *Construction Engineering Management Stream*, *7*(10), 181–188.
5. Batouli, M., Bienvenu, M., &Mostafavi, A. (2017). Putting sustainability theory into roadway design practice: Implementation of LCA and LCCA analysis for pavement type selection in real world decision making. *Transportation Research Part D: Transport and Environment*, *52*, 289–302. https://doi.org/10.1016/J.TRD.2017.02.018
6. *Putting sustainability theory into roadway design practice: Implementation of LCA and LCCA analysis for pavement type selection in real world decision making | Request PDF*. (n.d.). Retrieved May 11, 2022, from https://www.researchgate.net/publication/315500230_Putting_sustainability_theory_into_roadway_design_practice_Implementation_of_LCA_and_LCCA_analysis_for_pavement_type_selection_in_real_world_decision_making
7. Fini, E. H., Kalberer, E. W., Shahbazi, A., Basti, M., You, Z., Ozer, H., & Aurangzeb, Q. (2011). Chemical Characterization of Biobinder from Swine Manure: Sustainable Modifier for Asphalt Binder. *Journal of Materials in Civil Engineering*, *23*(11), 1506–1513. https://doi.org/10.1061/(ASCE)MT.1943-5533.0000237

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